Review

Research progress of chemical composition and pharmacological activity of *Boenninghausenia sessilicarpa* Lévl.

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Abstract

***Boenninghausenia sessilicarpa* Lévl. is a commonly used folk medicine in southwest Yunnan. It has the effects of clearing heat and detoxifying, promoting qi circulation and activating blood circulation. It is used to treat various conditions such as colds, tonsillitis, mumps, lung-heat induced cough and asthma, abdominal distension and pain, pyelonephritis, gangrene of the extremities, low back pain, and bruises from falls and injuries. This paper summarizes recent research progress on the chemical constituents and pharmacological activities of Boenninghausenia sessilicarpa Lévl., aiming to advance fundamental and clinical studies on this plant and provide a reference for enhanced medical utilization.**

Keywords: *boenninghausenia sessilicarpa* Lévl.; chemical composition; pharmacological activity

1 Introduction

The Yi ethnic medicine *Boenninghausenia sessilicarpa* Lévl. (abbreviated as *B. sessilicarpa* Lévl.) is the dried whole herb of *B. sessilicarpa* Lévl., a plant of the Rutaceae family [1]. First recorded in Diannan Bencao (Materia Medica of Yunnan) [2], it has subsequently been documented in various Chinese herbal medicine books and standards [3-5]. Also known by aliases such as Jiuniuerhucao, Tongjiaoyizhihao, Baihucao, and Yangshancao, it is distributed in regions including Sichuan and Yunnan in China [6,7]. It has the effects of clearing heat and detoxifying, promoting qi circulation and activating blood circulation. It is used to treat conditions including common cold, tonsillitis, mumps, lung-heat induced cough and asthma, distending pain in the epigastrium and abdomen, pyelonephritis, gangrene of the extremities, lumbago, and traumatic injury [8]. Modern pharmaceutical research shows that *B. sessilicarpa* Lévl. mainly contains various chemical constituents such as coumarins, terpenoids, flavonoids, and alkaloids [9]. *B. sessilicarpa* Lévl. and its active ingredients have pharmacological activities, such as anti-inflammatory, antibacterial, and anti-tumor effects [10]. This article systematically reviews recent research on the chemical constituents and pharmacological activities of *B. sessilicarpa* Lévl., aiming to provide a reference for enhanced medical development of utilization.

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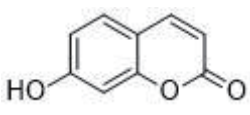
2 Chemical composition

2.1 Coumarins

Luo et al. extracted the ethanol extract of *B. sessilicarpa* Lévl. with ether, separated it by silica gel column chromatography, and eluted it with chloroform-methanol to obtain coumarin compounds umbelliferone (**1**), scopoletin (**2**), Matsukaz-lactone (**3**), and 5,8-dimethoxyxanthyletin (**4**) [11]. Chen et al. isolated two coumarin compounds, shijiaocaolactone A (**5**) and rutamarin (**6**), from the ether extract of the whole herb of *B. sessilicarpa* Lévl. [12]. Hao et al. carried out reflux extraction on *B. sessilicarpa* Lévl. with ethanol (concentration 85%). After concentration, the extract was dissolved with HCl. The acidic solution was extracted with benzene, and then the non-alkaloid part was obtained and subjected to silica gel column chromatography. Six coumarin compounds including daphnetin (**7**) and Jayantinin (**8**) were obtained [13]. Yang et al. isolated nine coumarin compounds from *B. sessilicarpa* Lévl., including 9'-methoxyl rutarensin (**9**), chalepensin (**10**), rutarensin (**11**), 5,7-dimethoxycoumarin (**12**), xanthotoxin (**13**), isopimpinellin (**14**), leptodactylone (**15**), and 5,7,8-trimethoxycoumarin (**16**) [17].He carried out cold soaking extraction on *B. sessilicarpa* Lévl. with ethanol (concentration 85%). After concentration, chromatographic separation was carried out to obtain twelve coumarin compounds including 6-(*trans*-1-buten-3-oxo)-7-methoxycoumarin (**17**), thamnosmonin (**18**), bergapten (**19**), graveolone (**20**), xanthyletin (**21**), byakangelicin (**22**), and evadine B (**23**) [15]. Jiang et al. separated and purified the petroleum ether extraction part of the ethanol extract of the whole herb of *B. sessilicarpa* Lévl., and identified the structures of the monomer compounds based on the spectral data of the compounds. Ten coumarin compounds were isolated from *B. sessilicarpa* Lévl. for the first time, namely osthenol methyl ether (**24**), murpanin (**25**), 3-(1,1-dimethylallyl)-8-hydroxy-7-methoxycoumarin (**26**), aurapten (**27**), isonordictyol (**28**), imperatorin (**29**), phellopterin (**30**), angelicin (**31**), luvangetin (**32**), 3-(1,1-dimethylallyl)-xanthyletin (**33**). At the same time, five known coumarin compounds including neocnidilin (**34**) were obtained [16]. The chemical structures of the coumarin compounds in *B. sessilicarpa* Lévl. are shown in Fig. 1. *B. sessilicarpa* Lévl. contains a variety of coumarins. All share the basic structure of benzopyran-2-one, formed by fusion of a benzene ring and an *α*-pyrone ring. Structural differences significantly influence their pharmacological activities. For simple coumarins such as umbelliferone, the substituents on the benzene ring influence its activity. The phenolic hydroxyl group endows it with antioxidant properties, providing hydrogen atoms to scavenge free radicals. The planar structure facilitates binding to bacterial targets and exerting antibacterial effects. For pyranocoumarins such as rutamarin, the pyran ring and its substituents affect their interactions with biological targets. Existing research has shown that some pyranocoumarins can regulate the cell cycle and induce apoptosis to exert anti-tumor effects. Praeruptorin A can inhibit the expression of proteins related to tumor cell migration and invasion, thus playing an anti-cancer role. Therefore, it is speculated that the pyranocoumarins in *B. sessilicarpa* Lévl. may have similar anti-tumor mechanisms, which are worthy of in-depth exploration [17-19].



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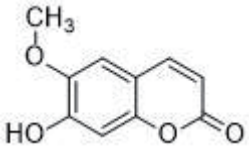

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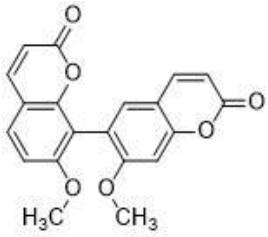

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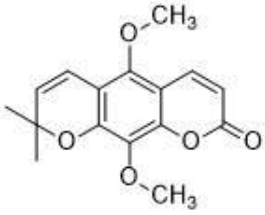

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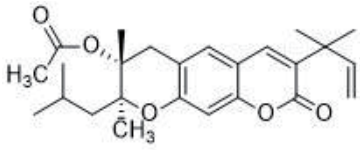

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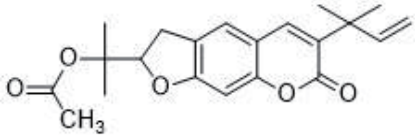

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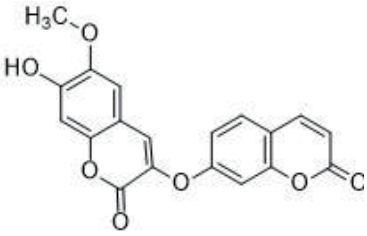

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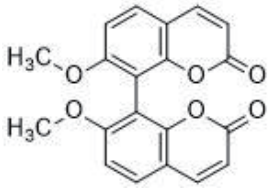

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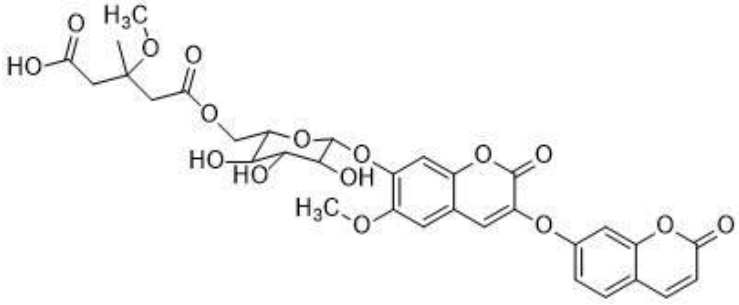

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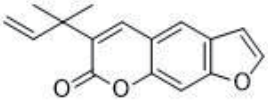

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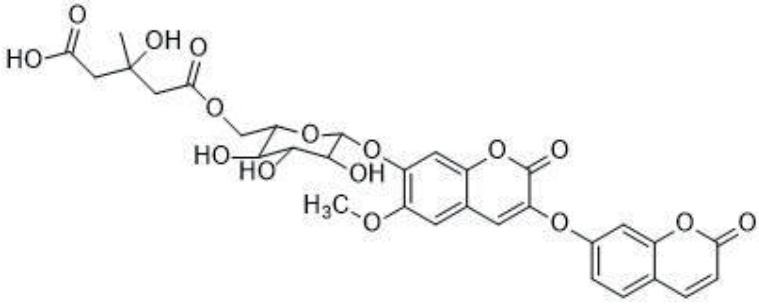

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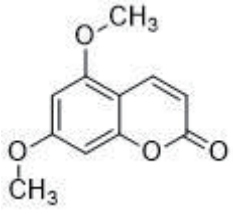

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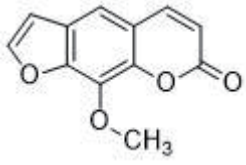

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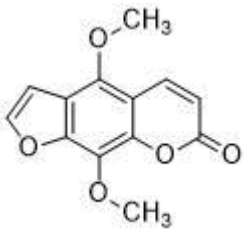

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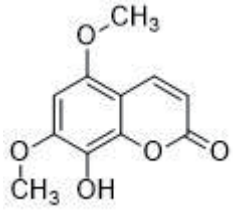

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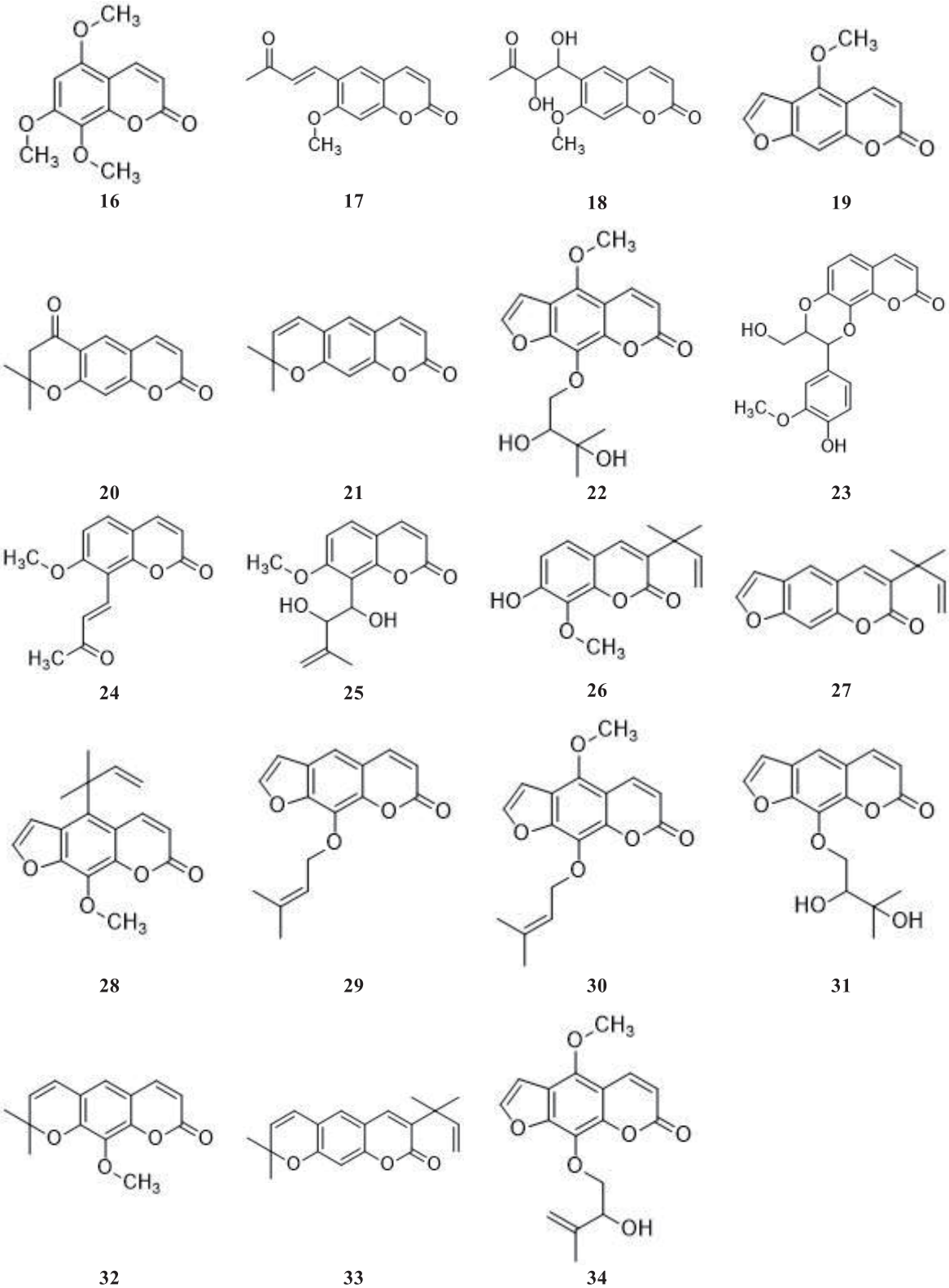


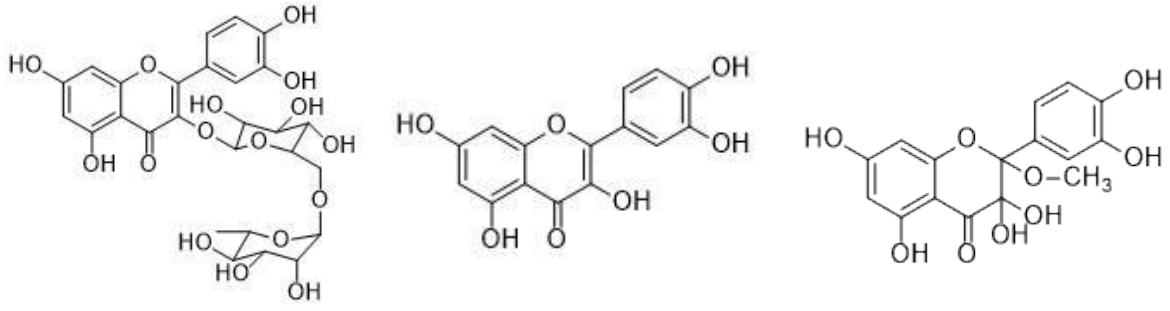
Fig. 1 Coumarins in *B. sessilicarpa* Lévl.

2.2 Terpenoids

Zhao et al. obtained essential oil by steam distillation, and used the Finnigan-4510 capillary gas chromatography-mass spectrometry-computer combination method to isolate and identify 33 compounds from the essential oil of *B. sessilicarpa* Lévl. Among them, the terpenoids include *α*-thujene (**35**), *α*-pinene (**36**), sabinene (**37**), *β*-pinene (**38**), myrcene (**39**), *α*-phellandrene (**40**), 3-carene (**41**), p-cymene (**42**), 1,8-cineole (**43**), *β*-phellandrene (**44**), allo-ocimene (**45**), fenchone (**46**), terpineol-4-ol (**47**), myrtenal (**48**), *α*-terpineol (**49**), isobornyl acetate (**50**), caryophyllene (**51**), geranyl acetate (**52**), caryophyllene (**53**), guaiene (**54**), humulene (**55**), *β*-cubebene (**56**), *δ*-cadinene (**57**), caryophyllene oxide (**58**), and cadalene (**59**) [20]. Liu L Z et al. used steam distillation to extract the volatile oil from the aerial parts of *B. sessilicarpa* Lévl. and analyzed it by gas chromatography-mass spectrometry. A total of 42 volatile oil components were identified, among which 39 were terpenoids, including (+)-4-carene (**60**), *γ*-terpinene (**61**), *α*-terpinolene (**62**), linalool (**63**), thujone (**64**), trans-pinocarveol (**65**), 1,4-dimethylcyclohex-3-enyl methyl ketone (**66**), sabina ketone (**67**), 4-terpineol (**68**), *p*-cymen-8-ol (**69**), myrtenal (**70**), (*S*)-verbenone (**71**), carvacrol (**72**), *p*-menth-1,4-dien-7-ol (**73**), *α*-cubebene (**74**), copaene (**75**), *β*-bourbonene (**76**), *β*-elemene (**77**), 10*S*,11*S*-Himachala-3(12),4-diene (**78**), 1,2,4*a*,5,6,8*a*-hexahydro-4,7-dimethyl-1-(1-methylethyl) naphthalene (**79**), calarene (**80**), 1,4,7,-cycloundecatriene,1,5,9,9-tetramethyl-,*Z*,*Z*,*Z*-(**81**), allo-aromadendrene (**82**), germacrene D (**83**), *α*-selinene (**84**), *α*-muurolene (**85**), 1*ξ*,6*ξ*,7*ξ*-cadina-4,9-diene (**86**), *β*-cadinene (**87**), cadine-1,4-diene (**88**), (*E*)-nerolidol (**89**), (-)-spathulenol (**90**), *α*-cadinol (**91**) and phytol (**92**). [21]. He carried out cold soaking extraction on *B. sessilicarpa* Lévl. with ethanol (concentration 85%). After concentration, chromatographic separation was carried out to obtain terpenoids oleanolic acid (**93**), 4*β*,10*α*-dimethyl-1*β*,5*α*bicycle[3.5.0]dec-6-en-4*α*,10*β*-diol (**94**) [15]. *B. sessilicarpa* Lévl. contains a variety of terpenoids, and their structures are closely related to pharmacological activities. Terpenoids are composed of isoprene units, and different linkages and functional group modifications endow them with diverse activities. Monoterpenes such as *α*-pinene and *β*-pinene contain unsaturated bonds and cyclic structures. The double bonds and rings affect the molecular polarity and spatial conformation, thus determining the pharmacological activities. In terms of antibacterial effects, the hydrophobic part inserts into the bacterial cell membrane, interferes with its function, and inhibits bacterial growth. In anti-inflammatory aspects, *α*-pinene inhibits the activity of key proteins in the inflammatory signaling pathway, reduces the production of inflammatory mediators, and plays an anti-inflammatory role. Oleanolic acid belongs to pentacyclic triterpenoids, with a unique pentacyclic structure and multiple hydroxyl groups. It performs outstandingly in liver protection. It regulates the activity of metabolic enzymes in liver cells, enhance the liver's detoxification function, and reduce liver damage. At the same time, it also has anti-inflammatory and anti-tumor activities. It inhibits the activation of inflammatory cells and the release of mediators, induce the differentiation of tumor cells, and inhibit their proliferation [22,23]. There are also studies indicating that some sesquiterpenoids induce the apoptosis of tumor cells, activate apoptosis-related proteins, and promote the programmed death of tumor cells. In anti-inflammatory aspects, sesquiterpenoids inhibit the activity of cyclooxygenase, reduce the synthesis of prostaglandins, and relieve the inflammatory response. They also have antioxidant activity. The unsaturated bonds and special functional groups in their structures neutralize free radicals and protect cells from oxidative damage [24].

2.3 Flavonoids

The Organic Group of the Department of Chemistry, Yunnan University, isolated and identified flavonoid glycosides from the water decoction of *B. sessilicarpa* Lévl. Rustin was identified through ultraviolet spectroscopy, the preparation of hydrolysis product derivatives, the determination of melting point, and comparison of the chromatography with the standard rutin (**95**) [25]. Luo et al. obtained the mother liquor after extracting the ethanol extract of *B. sessilicarpa* Lévl. with ether. After precipitation, the flavonoid compound rutin was identified [11]. They carried out cold soaking extraction on *B. sessilicarpa* Lévl. with ethanol (concentration 85%). After concentration, chromatographic separation was carried out to obtain flavonoids quercetin (**96**), rutin, and 5,7,3',4'-tetrahydroxy-2-methoxy-3,4-flavandione 3-hydrate (**97**) [15]. The chemical structures of the flavonoids in *B. sessilicarpa* Lévl. are shown in Fig. 2. Scholars have also discovered various flavonoids in *B. sessilicarpa* Lévl. These compounds share a C6-C3-C6 skeleton, where two benzene rings are connected by three carbon atoms. Modern pharmacological studies have shown that flavonoids possess functions such as antioxidant, anti-tumor, antibacterial, antiviral, hypoglycemic, and free radical scavenging [26-28].

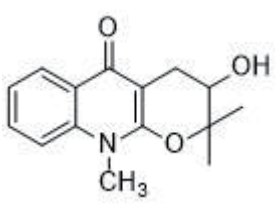


95 **96** **97**

Fig. 2 Flavonoids in *B. sessilicarpa* Lévl.

2.4 Alkaloids

The Organic Group of the Department of Chemistry, Yunnan University, isolated and identified alkaloids from the water decoction of *B. sessilicarpa* Lévl. Through the determination of ultraviolet spectroscopy, infrared spectroscopy, and nuclear magnetic resonance spectroscopy, the alkaloid was identified as benzyl benzoate from *B. sessilicarpa* Lévl. (**98**) [25]. Hao et al. carried out reflux extraction on *B. sessilicarpa* Lévl. with ethanol (concentration 85%). After concentration, the extract was dissolved with HCl. The acidic solution was extracted with benzene, and the alkaloid part obtained was subjected to silica gel column chromatography, and the alkaloid compound benzyl benzoate from *B. sessilicarpa* Lévl. was also obtained [13]. He carried out cold soaking extraction on *B. sessilicarpa* Lévl. with ethanol (concentration 85%). After concentration, chromatographic separation was carried out to obtain alkaloid compounds noracroycine (**99**) and 1-hydroxy-*N*-methylacridone (**100**) [15]. The chemical structures of the alkaloid compounds in *B. sessilicarpa* Lévl. are shown in Fig. 3.



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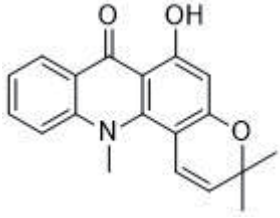

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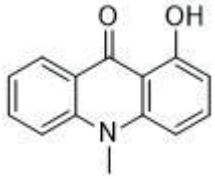

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Fig. 3 Alkaloids in *B. sessilicarpa* Lévl.

2.5 Other compounds

Scholars have also found various other types of chemical constituents in *B. sessilicarpa* Lévl., such as alcohol compounds hexanol (**101**) and octacosanol (**102**) [20,29], aldehyde compounds cuminaldehyde (**103**), decanal (**104**), and benzaldehyde (**105**) [20,21], ester compounds nerol acetate (**106**) and decyl acetate (**107**) [20], hydrocarbon compounds heptadecane (**108**), hentriacontane (**109**), and tetratriacontane (**110**) [20,29], *O*-cymene (**111**) and 4-vinylguaiacol (**112**) [21]. (seen in Table 1)

Table 1 Chemical constituents isolated from *B. sessilicarpa* Lévl.

Category	No.	Compound name	Reference	Category	No.	Compound name	Reference
Coumarins	**1**	umbelliferone	[11,13,15]		**57**	*δ*-cadinene	[20]
	2	scopoletin	[11,13,15]		**58**	caryophyllene oxide	[20]
	3	7,7'-Dimethoxy-6,8'-biscoumatsukaz-lactone	[11,13]		**59**	cadalene	[20,21]
	4	5,8-dimethoxyxanthyletin	[11]		**60**	(+)-4-carene	[21]
	5	shijiaocaolactone A	[12]		**61**	*γ*-terpinene	[21]
	6	rutamarin	[12-16]		**62**	*α*-terpinolene	[21]
	7	daphnoretin	[13]		**63**	Linalool	[21]
	8	jayantinin	[13]		**64**	thujone	[21]
	9	chalepensin	[14]		**65**	trans-pinocarveol	[21]
	10	9'-methoxyl rutarensin	[14]		**66**	1,4-dimethylcyclohex-3-enyl methyl ketone	[21]
	11	rutarensin	[14]		**67**	sabina ketone	[21]
	12	5,7-dimethoxycoumarin	[14]		**68**	4-terpineol	[21]
	13	xanthotoxin	[14,16]		**69**	*p*-cymen-8-ol	[21]
	14	isopimpinellin	[14-16]		**70**	myrtenal	[21]
	15	leptodactylone	[14]		**71**	(*S*)-verbenone	[21]

(to be continued)

Continued Table 1

Category	No.	Compound name	Reference	Category	No.	Compound name	Reference
	16	5,7,8-trimethoxycoumarin	[14]		**72**	carvacrol	[21]
	17	6-(*trans*-1-buten-3-oxo)-7-methoxycoumarin	[15]		**73**	*p*-menth-1,4-dien-7-ol	[21]
	18	thamnosmonin	[15]		**74**	*α*-cubebene	[21]
	19	bergapten	[15]		**75**	Copaene	[21]
	20	graveolone	[15]		**76**	*β*-bourbonene	[21]
	21	xanthyletin	[15]		**77**	*β*-elemene	[21]
	22	byakangelicin	[15,16]		**78**	10*S*,11*S*-Himachala-3(12),4-diene	[21]
	23	evadine B	[15]		**79**	1,2,4*a*,5,6,8*a*-hexahydro-4,7-dimethyl-1-(1-methylethyl) naphthalene	[21]
	24	osthenol methyl ether	[16]		**80**	calarene	[21]
	25	murpanin	[16]		**81**	1,4,7,-cycloundecatriene,1,5,9,9-tetramethyl-,Z,Z,Z-	[21]
	26	3-(1,1-Dimethylallyl)-8-hydroxy-7-methoxycoumarin methyl ether	[16]		**82**	allo-aromadendrene	[21]
	27	aurapten	[16]		**83**	germacrene D	[21]
	28	isonordictyol	[16]		**84**	*α*-selinene	[21]
	29	imperatorin	[16]		**85**	*α*-muurolene	[21]
	30	phellopterin	[16]		**86**	1*ξ*,6*ξ*,7*ξ*-cadina-4,9-diene	[21]
	31	angelicin	[16]		**87**	*β*-cadinene	[21]
	32	luvangetin	[16]		**88**	cadine-1,4-diene	[21]
	33	3-(1,1-dimethylallyl)-xanthyletin	[16]		**89**	(*E*)-nerolidol	[21]
	34	neocnidilin	[16]		**90**	(-)-spathulenol	[21]
Terpenoids	**35**	*α*-thujene	[20,21]		**91**	α-cadinol	[21]
	36	*α*-pinene	[20,21]		**92**	phytol	[21]
	37	sabinene	[20]		**93**	oleanolic acid	[15]
	38	*β*-pinene	[20,21]		**94**	4*β*,10*α*-dimethyl-1*β*,5*α*bicycle[3.5.0]dec-6-en-4*α*,10*β*-diol	[15]
	39	myrcene	[20]	Flavonoids	**95**	rutin	[11,15,25]

(to be continued)

Continued Table 1

Category	No.	Compound name	Reference	Category	No.	Compound name	Reference
	40	*α*-phellandrene	[20]		**96**	quercetin	[15]
	41	3-carene	[20]		**97**	5,7,3',4'-tetrahydroxy-2-methoxy-3,4-flavandione3-hydrate	[15]
	42	*p*-cymene	[20,21]	Alkaloids	**98**	benzyl benzoate from *B. sessilicarpa* Lévl.	[13,25]
	43	1,8-cineole	[20]		**99**	noracroycine	[15]
	44	*β*-phellandrene	[20,21]		**100**	1-hydroxy-N-methylacridone	[15]
	45	allo-ocimene	[20]	Other	**101**	hexanol	[20]
	46	Fenchone	[20]		**102**	octacosanol	[29]
	47	terpineol-4-ol	[20]		**103**	cuminaldehyde	[20]
	48	myrtenal	[20]		**104**	decanal	[20]
	49	*α*-terpineol	[20]		**105**	benzaldehyde	[21]
	50	isobornyl acetate	[20]		**106**	neryl acetate	[20]
	51	Caryophyllene	[20]		**107**	decyl acetate	[20]
	52	geranyl acetate	[20]		**108**	heptadecane	[20]
	53	Caryophyllene	[20]		**109**	hentriacontane	[29]
	54	Guaiene	[20]		**110**	tetratriacontane	[29]
	55	Humulene	[20]		**111**	*O*-cymene	[21]
	56	*β*-cubebene	[20]		**112**	4-vinylguaiacol	[21]

3 Pharmacological activities

At present, it has been proved that *B. sessilicarpa* Lévl has a variety of pharmacological effects, as shown in Fig. 4.

Fig. 4 Pharmacological activities of *B. sessilicarpa* Lévl

3.1 Anti-inflammatory effect

Zhao conducted a study on the pharmacological effects of *B. sessilicarpa* Lévl. tablets in the treatment of urinary tract infections. The whole herb of *B. sessilicarpa* Lévl. collected in summer and autumn was washed, dried in the shade, sliced, ground, and then made into tablets through water

extraction, filtration, and concentration. These tablets showed good efficacy in the treatment of acute urinary tract infections. They could relieve symptoms such as frequent urination, urgent urination, painful urination, and low back pain, and promote the recovery of normal urine routine. The time required for cure and improvement was comparable to that of the furadantin group. The side effects were minimal, mainly self-resolving mild upper abdominal discomfort. No adverse effects were observed on liver function, pregnant women, or fetuses. However, treatment of chronic pyelonephritis carried a risk of recurrence, and a potential association with decreased white blood cells was noted, requiring further research. [30]. Meng found that *B. sessilicarpa* Lévl. had an antibacterial effect on Streptococcus pneumoniae during the drug sensitivity test. Later, clinical practice also confirmed that the decoction of *B. sessilicarpa* Lévl. had a good effect on lobar pneumonia, and no adverse reactions were found [31]. Gong et al. employed ultrasonic-assisted extraction using water, ethanol, ethyl acetate, petroleum ether and dichloromethane to obtain different polar fractions in *B. sessilicarpa* Lévl.. Using the xylene-induced ear swelling test, anti-inflammatory activity was confirmed in these fractions, which were then preliminarily characterized. Results showed that the all five extracts significantly inhibited xylene-induced ear swelling in mice [32].

3.2 Antibacterial effect

Luo et al. first extracted the ethanol extract of *B. sessilicarpa* Lévl. with ether. Susequent separation by silica gel column chromatography with chloroform-methanol as eluent yielded coumarin compounds such as umbelliferone, scopoletin, and 7,7'-dimethoxy-6,8'-bis-coumarin. Using the cup-plate method, an *in vitro* antibacterial test was carried out on the first three compounds with Bacillus subtilis ATCC1633, Staphylococcus aureus 209P, Escherichia coli NIJH, Alcaligenes faecalis ATU875C, and Mycobacterium 607 as test strains. Results showed that these compounds had a certain inhibitory effect on Bacillus subtilis and Staphylococcus aureus [11]. Yin et al. extracted the alcohol-soluble components in *B. sessilicarpa* Lévl. by the maceration extraction method using ethanol as the solvent, and then concentrated into an extract paste. The extract paste was further separated and extracted with different solvents to prepare the total extract of *B. sessilicarpa* Lévl. and its separated extracts. Using Staphylococcus aureus, Pseudomonas aeruginosa, Proteus, Escherichia coli, Bacillus subtilis, Salmonella typhi, Shigella, Aerobacter aerogenes, Streptococcus pyogenes, and Candida albicans as the bacterial strains, the disk diffusion method was used to observe the inhibitory effects of the total extract of *B. sessilicarpa* Lévl. and its separated extracts on 11 common pathogenic bacteria. Results showed that the total extract of *B. sessilicarpa* Lévl. and 3 of its separated extracts had good inhibitory effects on Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa, and Streptococcus pyogenes [33]. Gong et al. used water, ethanol, ethyl acetate, petroleum ether and dichloromethane to extract the active components of different polar parts in *B. sessilicarpa* Lévl. by ultrasonic-assisted extraction. The antibacterial activity of the active components of different polar parts in *B. sessilicarpa* Lévl. was investigated by the antibacterial zone test and the minimum inhibitory concentration (MIC) test. Results showed that the extracts of water, ethanol, ethyl acetate and dichloromethane had inhibitory effects on Staphylococcus aureus, Pseudomonas aeruginosa, Bacillus subtilis and Escherichia coli, and the diameters of the antibacterial zones were 9.3-14.7 mm. The above four bacteria were the most sensitive to the ethanol extract, and the MIC values were 12.5 μg/mL, 12.5 μg/mL, 25 μg/mL and 25 μg/mL, respectively [34].

3.3 Antitumor effect

Yang et al. isolated 9 coumarins from *B. sessilicarpa* Lévl., among which rutamarin had obvious inhibitory effects on tumor cells such as A-549, Bel-7402, HepG-2 and HCT-8, and the IC_{50} values were 1.318, 2.082, 2.306 and 2.497 mg/mL, respectively. In addition, the compound leptodactylone had a strong protective effect on cells infected with SARS virus, and the protection rate reached 60% at 100 mg/mL [14].

3.4 Other pharmacological activities

Yang et al. studied the biological activities and action mechanisms of the extracts of *B. sessilicarpa* Lévl. on Panonychus citri and Tetranychus cinnabarinus. Results showed that the extracts of *B. sessilicarpa* Lévl. had strong biological activities on both Panonychus citri and Tetranychus cinnabarinus. Among the extracts obtained by different procedures using four organic solvents with different polarities (ethanol, ethyl acetate, petroleum ether and chloroform), ethanol had the strongest biological activity. When the single extraction concentration was 4 mg/mL, the corrected mortality rate of Panonychus citri reached 93.03% within 24 h [35-37]. Liu et al. extracted the volatile oil from the aerial parts of *B. sessilicarpa* Lévl. by steam distillation method, and studied the contact toxicity against the stored grain pests Sitophilus zeamais and Tribolium castaneum. Results showed that the LD_{50} values of the volatile oil of *B. sessilicarpa* Lévl. for the adults of Sitophilus zeamais and Tribolium castaneum were 15.25 and 6.02 μg/adult, respectively, and the volatile oil from the aerial parts of *B. sessilicarpa* Lévl. had potential acute toxicity against stored grain pests [21].

4 Conclusion

B. sessilicarpa Lévl., as a traditional ethnic medicine, is widely distributed in southwest China with remarkable curative effect and great development potential. In recent years, scholars at home and abroad have studied its chemical composition, pharmacological activities, extraction processes [38,39], and quality control [40]. However, current research on it is insufficient, and there is still room for expansion in multiple aspects. In terms of chemical composition research, although various types of components have been identified, there are still potential components to be discovered. In the future, network pharmacology can be employed to construct an association network between the chemical components of *B. sessilicarpa* Lévl. and disease targets, predict its potential active components and action mechanisms, and provide guidance for in-depth research. Meanwhile, the bioassay-guided isolation method can be adopted. By using specific pharmacological activities as a guide, active constituents can be accurately screened, improving research efficiency. The research on the pharmacological activity mechanism of *B. sessilicarpa* Lévl. is currently at a preliminary stage. More *in vivo* models should be established in the future to simulate the complex physiological environment of the human body and deeply explore its action pathways and targets *in vivo*. For example, animal inflammation models can be used to study the specific molecular mechanisms of its anti-inflammatory activity, and tumor animal models can be utilized to analyze the detailed process of its anti-tumor activity, clarifying how active components regulate processes such as cell proliferation and apoptosis *in vivo*, thus providing solid theoretical basis for clinical applications. In-depth research on *B. sessilicarpa* Lévl. can facilitate comprehensive utilizaiton its medicinal value, enhance clinical application and drug development, promote the modernization of traditional ethnic medicines, and maximize its contribution to contemporary healthcare.

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